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NOTES ON THE ECOLOGY OF SEWER RATS IN ST. LOUIS

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The awareness, if not the magnitude, of problems caused by sewer rats has increased in the United States in recent years. Thus, current concern with the more general problem of urban rats is leading many city agencies to incorporate plans for controlling sewer rats in budgets that are already severely strained. The most effective programs for controlling pests are those based on an intimate knowledge of the interactions between the target species and its environment. Some basic studies of sewer rat ecology were begun in St. Louis, Missouri, in February, 1969. Since the initial results have provided information that should be helpful in planning control operations in other cities, a brief account of the relevant findings will be presented here so that the information may become available before the study is completed and published in fuller detail.

The most extensive studies of sewer rats in the United States have been conducted in California, where sanitary sewers are generally separate from storm systems and where roof rats (Rattus rattus) are often the dominant species (e.g. Rohe, 1966). Much work has also been done in Great Britain, where the sewer networks sometimes seem to defy simple description. Recent work there (e.g. Greaves, et al, 1968), as in California, has been mainly in evaluating methods of control, although some analyses of the systems from an ecological viewpoint have been made. Neither of these groups of studies has been in sewer systems that seem directly comparable to the combined storm and sanitary sewers of St. Louis and a need for more specific basic information on the characteristics of sewer rats was recognized. The most frequently cited paper on the rats of combined sewer systems in the United States (Beck and Rodeheffer, 1965) does not describe the methods used and thus the results and conclusions are difficult to evaluate. In contrast to earlier studies, we started simply with the question, "What characteristics of the sewer system influence the numbers, distribution, and behavior of sewer rats?" R. norvegicus is probably the only vertebrate species that lives in our sewers.

SEASONAL CHANGES IN SEWER RAT ACTIVITY

Our original concept of the sewer system as a habitat for rats was that it should be relatively stable, with moderated temperatures and a constant daily supply of food passing any particular point. It was somewhat of a surprise to learn that the take of poison placed in sewers by city personnel had dropped sharply in January, 1969, and that a similar event was said to have occurred a year previously. During the 15 months of sewer baiting conducted by the city, the pattern had been to move from one area to another as a reduction in take implied success in control. Thus, no area had ever been baited for more than a single period. It was evident that considerable variation existed among the areas and we were not sure that the "seasonal" changes in rat activity were real or due to sampling error.

To provide a more valid measure of seasonal changes, 44 areas were selected to represent a variety of surface and drainage conditions in the city. In each area we picked ten manholes at random from those that occurred in alleys. Thus, no main trunk lines were sampled; outlet diameters ranged from 8 to 48", with the modal group being 15 to 18". Four ounces of cracked corn and rolled oats in a plastic bag were lowered to the bottom of each manhole by a string which was then fastened to a nail driven into the mortar at the top of the hole. The take at each hole was recorded a week later during the first round of baiting and at two-week intervals through the eighth round. This procedure parallels the methods used by the city and reveals only the presence or absence of rat activity during the intervals between checks.

The city records, beginning in November, 1967 showed a sharp decline in the number of active holes with a low in February, 1968. Activity then increased from a prevalence of about 25% to 63% by June. A gradual but irregular decline was then terminated by a sharp drop to about 5% in January, 1969. The mean date for our first complete round of baiting was about the first of March and the prevalence of active manholes then increased from about 25% to 58% by June. Thus, in two consecutive years a rather pronounced annual cycle of sewer rat activity was recorded.

Seasonal changes in 1969 were rather synchronous around the city so the causes would appear to be associated with factors coming from outside the system. The virtual absence of surface populations in many areas rules out the possibility of a spring-time invasion. The most obvious alteration of the sewer environment comes from surface runoff following rain. It seems possible that the decline in the number of active holes is initiated by summer storms. These are likely to flush out the "surplus" population that is not attached to stable home ranges containing refugia.

Sewer temperatures approximate surface air temperatures during periods of heavy runoff and it is evident that sewer rats will be subjected to sudden chilling during winter rains and snow thaws. This seems the most likely explanation for the sharp drop in the prevalence of active holes during the winters of 1968 and 1969. This hypothesis is reinforced by the events of the next winter. Heavy snow fell in December 1969 but cold weather persisted and the snow either sublimed or trickled slowly into the sewers. January and February were unusually dry with no significant runoff. Extremely cold weather persisted but air temperatures at the bottoms of manholes having ventilated lids fell only a few degrees below the temperature of the sewage. A round of baiting in February and March indicated the level of activity was essentially what it had been in the fall--about 50%. Thus, no measurable winter decline in sewer rat activity occurred in the absence of cold runoff.

Beck and Rodeheffer (1965) suggested a similar cycle of abundance in the sewer rats of Akron, Ohio. This conclusion apparently was reached by observing burrowing activity around catch basins and by analysing the seasonal patterns of sewer-connected complaints, neither of which are necessarily related to the abundance of rats in the sewers. I should also add that the presence or absence of rat activity at manholes in St. Louis cannot be determined reliably by inspection. Sign is washed from ledges by high water and about half of our manholes have no ledges at the bottom.

TRANSIENTS

In June, 1969 we changed our methods to surplus baiting with daily checks for four consecutive days after placement, hoping to get an estimate of density during the peak of the activity curve. The pattern of take varied considerably among the active holes. Most exhibited a relatively constant take from day to day, some increased rapidly during this short period, while many holes produced a sporadic take, i.e. having a take recorded on one, two, or three of the four days. The last pattern was not due to a general lag in finding or accepting the bait, since single takes were as likely to occur on the first as on the fourth day. The long term records also showed some holes where token baits were taken during one or more periods and then were missed for one or more periods despite a general increase in the prevalence of activity.

The above observations suggest either that many rats in the sewer system are transients or that some holes lie outside the regular travel path of any rat with a stable home range and the bait does not evoke a return visit. The first interpretation seems the more likely and the occurrence of transients has important implications for control efforts. Examination of the city's records revealed large numbers of cases where fractions of baits were consumed over a one-week period. These baits were three-ounce cups of diphacin-grain mixture imbedded in parafin. For a rat to be killed, it would have to consume the equivalent of an entire cup over a three-day period. These wax baits are taken well by surface rats and it would appear that many sewer rats are simply passing through the system, not staying long enough at a bait point to consume a lethal dose of an anticoagulant. Maintaining bait stations at every hole in a drainage district would increase the probability of killing a transient with anticoagulants but the odds would probably be improved by using a suitable acute rodenticide. Anticoagulants are still recommended for baiting sewers (Bjornson, et al, 1968) but more critical tests of their relative efficacy are needed.

HOARDING BEHAVIOR

As indicated above, when surplus baited, many (39) holes showed an accelerating pattern of daily take. In the most extreme case this reached 72 oz per day (18 bags), an amount not likely to be consumed by the most dense of rat populations in small diameter sewers. Indeed, trapping did not reveal the presence of unusually high populations at such points. Some spillage from the bags did occur, but this in no way accounted for the take since the lost material would have been seen where ledges were present and runoff from rains did not remove the evidence. It was assumed that some rats were hoarding the bait.

To test this hypothesis, we selected 40 holes which had previously registered medium to high takes and divided them into four groups of ten each. Two groups were baited with cracked corn and two with cornmeal for one week. In the second week of baiting, the treatment was reversed in half the groups. Since Emlen, Stokes, and Davis (1949) reported that rats do not hoard cornmeal, we anticipated that the change from cracked corn to meal would result in a decline of take. This prediction proved correct; the decline amounted to 63%.

We did not anticipate that cornmeal would be hoarded. In fact it is, but to a lesser extent than the cracked corn. Several holes produced an accelerating take with meal. In five of the holes Alizarin Red S was added to the meal on the last two days of the test and the associated areas trapped the next week. One of the trapped rats had undyed bait in her stomach, despite that fact that plain meal had not been available for a period of five days.

These observations are important to workers who use bait consumption as a measure of rat abundance. Rohe (1966) has suggested using wax baits to measure consumption rates in sewers and this may have considerable merit.

CATCH BASINS

In our initial reconaissance of St. Louis sewers, catch basins were judged to be generally unsuitable as rat habitat since both food and harborage are usually absent. Therefore, we did not include catch basins in our baiting routine. Poisoning catch basins, however, is a recommended practice (Meyers, 1969) and in December, 1969, Joe Brooks told us that the sewer rat control program of one major city in New York State consisted solely of baiting catch basins. He raised doubts as to the value of this program and, having no hard facts to substantiate our agreement with his evaluation, we added two catch basins to our sample of ten manholes in most areas. Of 80 catch basins baited for a two-week period in early 1970, only two were active. At the same time, over 50% of the associated sewer manholes had bait taken by rats. In the winter, at least, catch basins are by far the poorest part of the sewer rat's habitat.

As indicated by Beck and Rodeheffer (1965) catch basins are occassionally defective and rats burrow to the surface outside the catch basin. Such burrows can be treated by conventional means rather than be treating catch basins in general.

DISCUSSION

The above observations coupled with an analysis of physical factors associated with rat activity in the sewers (which will be published later) suggest a dynamic pattern of sewer rat populations that may be used in an effective control strategy under appropriate circumstances. A growing population of sewer rats requires access to both adequate food and breeding harborage. As either of these resources becomes limiting in a particular locality, rats must emigrate to parts of the system where either food is marginally abundant or breeding harborage is absent. Rats in such habitats will be vulnerable to the effects of rain, either by having their marginal food source further diluted and hence being made less resistant to the effects of cold water in winter, or by being flushed downstream during summer storms. These relationships presumably explain the seasonal patterns of activity in St. Louis sewers.

Assuming that the major source of "problem" rats are emigrants from breeding foci, a logical strategy for reducing the problem in cities having combined sewers and a pattern of winter precipitation more dependable than that of St. Louis is to reduce the population in late winter, when it should be at its lowest point. If the breeding population can be drastically reduced, one can count on the lag in recovery to minimize the production of emigrants. The success of this strategy, of course, depends on the duration of the lag (which should be a function of the proportion killed) and on the extent to which seasonal changes influence a low, increasing population.

If baits are checked after a period of one or two weeks it should be possible to map the distribution of spring focal areas so that these can receive adequate attention during the critical period in later years. In St. Louis, about one-third of the manholes have never had bait taken by rats and it is rather pointless to bait such holes in hopes of killing a transient rat. If the proposed strategy is correct, few transients should be produced. Obviously this scheme for controlling sewer rat problems needs to be tested in appropriate cities. The logic of this procedure is to manage a population so as to reduce the size of the problem with a minimum of resources. Should the time come when we can afford to aim for a "rat-free" city, the strategy of sewer rat control will be different.

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